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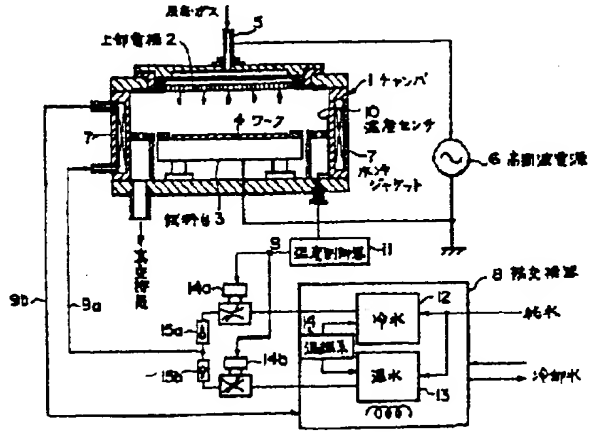

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TITLE : TEMPERATURE ADJUSTMENT MECHANISM OF WORK REACTION DEVICE

ABSTRACT : PURPOSE: To keep a temperature of an inner wall surface of a chamber wherein a required reaction process is executed nearly fixed in a temperature adjustment mechanism of a work reaction device.

CONSTITUTION: A temperature sensor 10 for directly detecting a temperature of an inner wall surface of a chamber 1 is provided thereto, a heat exchanger 8 for preparing cooling water of an arbitrary temperature based on a temperature signal detected by the temperature sensor 10 is provided and a water cooling jacket 7 for circulating cooling water supplied from the heat exchanger 8 around the chamber 1 is installed to enclose a circumference of the chamber 1. A temperature of an inner wall surface of the chamber 1 is made nearly fixed by circulating cooling water from the heat exchanger 8 to the water cooling jacket 7. Thereby, it is possible to restrain thermal stress due to temperature change of an inner wall surface of the chamber 1 and to prevent a film attaching to the inner wall surface from peeling.

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WORKPIECE REACTION DEVICE TEMPERATURE REGULATING MECHANISM

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[There are no amendments to this patent.]

Abstract

Purpose

To make it possible to keep the temperature of the inner wall surface of a chamber that executes requisite reaction processes fixed in a workpiece reaction device temperature regulating mechanism.

Constitution

Temperature sensor (10), that directly senses the temperature of the inner wall surface of chamber (1), is provided therefor, heat exchanger (8) that produces cooling water at any temperature based on temperature signals sensed by this temperature sensor (10) is provided, cooling water jacket (7), that circulates cooling water supplied from this heat exchanger (8) around aforementioned chamber (1) is installed to surround said chamber (1), and the temperature of the inner wall surface of aforementioned chamber (1) will be [kept] constant by circulating cooling water from aforementioned heat exchanger (8) in this cooling water jacket (7). Because of this, thermal stress caused by changes in temperature of the inner wall surface of said chamber (1) is suppressed and separation of the film adhered to this inner wall surface can be prevented.

Claims

1. Workpiece reaction device temperature regulating mechanism, characterized in that, in a workpiece reaction device temperature regulating mechanism where workpieces for manufacturing semiconductor products are housed in a chamber and that regulates the temperature inside the aforementioned chamber of the workpiece reaction device that executes requisite reaction processes for the aforementioned workpieces in an environment with prescribed conditions, a temperature sensor that directly senses the temperature inner wall surface of the aforementioned chamber is provided therefor, a heat exchanger that produces cooling water at any temperature based on temperature signals sensed by this temperature sensor is provided, a cooling water jacket that circulates cooling water supplied from this heat exchanger around the aforementioned chamber is installed to enclose said chamber, and the temperature of the inner wall surface of the aforementioned chamber is [kept] constant by circulating cooling water from the aforementioned heat exchanger to this cooling water jacket.

2. Workpiece reaction device temperature regulating mechanism described in Claim 1, and characterized in that the aforementioned heat exchanger has cold water and warm water at prescribed temperatures prepared inside it beforehand, and the aforementioned cold water and

warm water are mixed at any ratio according to temperature signals sensed by the aforementioned temperature sensor to produce cooling water at any temperature.

Detailed explanation of the invention

[0001]

Industrial application field

This invention pertains to a workpiece reaction device temperature regulating mechanism that regulates the temperature in a chamber of a workpiece reaction device, for example, a plasma treatment device or sputtering device that executes requisite reaction processes for wafers, etc. that serve as workpieces in semiconductor manufacturing processes, and in particular, it pertains to a temperature regulating mechanism that can keep the temperature of the aforementioned chamber inner wall surface constant.

[0002]

Prior art

Conventional workpiece reaction devices, for example, CVD devices as shown in Figure 2, have chamber (1) that is formed into a cylindrical shape the inside of which is in a vacuum state. At the top of this chamber (1) is an upper electrode (2) for generating plasma, and at the bottom opposite that is sample platform (3) which serves as a lower electrode. Workpiece (4) (a wafer for example) for manufacturing a semiconductor product will be mounted on this sample platform (3). Also, inside aforementioned sample platform (3) a heater is embedded to heat aforementioned workpiece (4) to about 300-400°C. Upper electrode (2) is formed to be hollow and at the same time to have a shower structure with many holes. Reaction gas will be sprayed inside chamber (1) from upper nozzle (5). In addition, the inside of aforementioned chamber (1) is evacuated by a vacuum pump (not shown in the figure) to a vacuum state of around 0.1-10 Torr. Note that symbol (6) represents a high-frequency power source that is connected to upper electrode (2).

[0003]

In a plasma CVD device of this sort, in order to execute a requisite reaction process for workpiece (4)--a process, for example, where a film of a certain type is formed on the surface of said workpiece (4)--workpiece (4) is mounted on the top surface of the aforementioned sample platform (3) and is also heated to a prescribed temperature, the inside of chamber (1) is made a vacuum at a prescribed pressure by the vacuum evacuation system, reaction gas is injected from upper nozzle (5), and, by impressing prescribed high-frequency voltage between upper electrode (2) and sample platform (3), plasma is generated inside aforementioned chamber (1). Because of

this, a film of a certain type is formed on the surface of aforementioned workpiece (4). In this case, a film is also formed on and adheres to the inner wall surface of aforementioned chamber (1).

[0004]

During plasma treatment such as the aforementioned, the temperature of the inner wall surface of said chamber (1) rises due to the generation of plasma inside chamber (1) and the temperature of the inner wall surface drops when plasma generation stops. So this cycle of temperature rise and fall is repeated each time multiple workpieces (4) are sequentially processed. In this case, the film adhered to the inner wall surface of aforementioned chamber (1) separates due to the thermal stress caused by changes in temperature of the aforementioned inner wall surface and adheres to workpiece (4) as foreign material.

[0005]

In contrast to this [approach], conventional temperature regulating mechanisms, as shown in Figure 2, are provided with a cooling water jacket (7) that surrounds aforementioned chamber (1), and are also provided with heat exchanger (8) that provides cooling water to this cooling water jacket (7). Cooling water at a fixed temperature lower than the temperature of the aforementioned chamber (1) is produced by this heat exchanger (8) and provided to cooling water jacket (7), and said chamber (1) is cooled by its being circulated around chamber (1). In this case, temperature sensor (10) is installed on cooling water supply line (9a) to cooling water jacket (7) from aforementioned heat exchanger (8), the temperature of the cooling water supplied to aforementioned cooling water jacket (7) is sensed, temperature controller (11) is activated based on this temperature signal, and the cooling water supplied to cooling water jacket (7) via supply line (9a) from aforementioned heat exchanger (8) is [kept] constant. Note that symbol (9b) represents the cooling water return line.

[0006]

Problems to be solved by the invention

However, in a conventional workpiece reaction device temperature regulating mechanism such as this, the temperature of the cooling water supplied to cooling water jacket (7) is sensed by temperature sensor (10) installed on supply line (9a), and the temperature of the cooling water supplied to aforementioned cooling water jacket (7) from heat exchanger (8) will be kept constant but even assuming that the temperature of the cooling water for cooling chamber (1) can be kept fixed, the temperature inside said chamber (1) cannot necessarily be kept constant. As discussed above, inside chamber (1) plasma generation and stopping is repeated with repeated

processing of workpieces (4), and each time the temperature of the inner wall surface of said chamber (1) rises and falls, temperature changes thereof cannot be suppressed by cooling water at a fixed temperature. From this fact, as shown by dotted line curve (C1) in Figure 3, the temperature of the inner wall surface of aforementioned chamber (1) would rise due to plasma generation and fall due to the generation ceasing as a matter of course. Thus, there would be instances when the film adhered to the inner wall surface of said chamber (1) separates due to the thermal stress caused by temperature changes in the inner wall surface of this chamber (1), and would adhere to workpieces (4) as foreign material. Because of this, not only would the quality of the semiconductor products manufactured drop, but yield would [also] drop.

[0007]

So, this invention will handle problems such as this, and its purpose is to provide a workpiece reaction device temperature regulating mechanism that can keep the temperature of the inner wall surface of the chamber that executes requisite reaction processes constant.

[0008]

Means to solve the problems

In order to accomplish the aforementioned purpose with the workpiece reaction device temperature regulating mechanism based on this invention, in [such] a workpiece reaction device temperature regulating mechanism, where workpieces for manufacturing semiconductor products are housed inside a chamber, and that regulates the temperature inside the aforementioned chamber of the workpiece reaction device, that executes requisite reaction processes for the aforementioned workpieces in an atmosphere with prescribed conditions, a temperature sensor that directly senses the temperature of the inner wall surface of the aforementioned chamber is provided therefore; a heat exchanger that produces cooling water at any temperature based on the temperature signals sensed by this temperature sensor is provided, a cooling water jacket that circulates cooling water supplied from this heat exchanger around the aforementioned chamber is installed to surround said chamber, and the temperature of the inner wall surface of the aforementioned chamber is made constant by circulating cooling water from the aforementioned heat exchanger to this cooling water jacket.

[0009]

And the aforementioned heat exchanger, with cold water and warm water of prescribed temperatures prepared beforehand inside it, mixes the aforementioned cold water and warm water at any ratio according to temperature signals sensed by the aforementioned temperature sensor to produce cooling water at any temperature.

[0010]

Action

A workpiece reaction device temperature regulating mechanism constituted in this way operates so that the temperature of the inner wall surface of said chamber is directly sensed by the temperature sensor installed on the inner wall surface of the chamber, cooling water of any temperature is produced based on the temperature signals sensed by the aforementioned temperature sensor by a heat exchanger that is provided separately from the aforementioned chamber, cooling water from the aforementioned heat exchanger is supplied to a cooling water jacket that is installed to surround the aforementioned chamber, and the temperature of the inner wall surface of the aforementioned chamber is made fixed by circulating cooling water around the chamber with the aforementioned cooling water jacket. Because of this, thermal stress caused by temperature changes in the inner wall surface of the aforementioned chamber are suppressed and separation of the film adhered to its inner wall surface can be prevented.

[0011]

Application example

Below, an application example of this invention will be explained in detail based on the accompanying figure. Figure 1 is a partial cross-section explanatory diagram showing an application example of a workpiece reaction device temperature regulating mechanism based on this invention. This workpiece reaction device temperature regulating mechanism regulates the temperature inside the chamber of, for example, a plasma processing device that executes requisite reaction processes for wafers, etc., as the workpieces in the semiconductor manufacturing process. First, as a type of plasma treatment device, for example, the plasma CVD device shown in Figure 1, has chamber (1), the inside of which is formed, for example, into a cylindrical shape, is at a vacuum, and inside this chamber (1) is upper electrode (2) for generating plasma. Sample platform (3), that serves as a lower electrode, is below and opposite that, and workpiece (4) (for example, a wafer) for manufacturing a semiconductor product is mounted on this sample platform (3). Also, inside aforementioned sample platform (3), a heater is embedded to heat that aforementioned workpiece (4) to around 300-400°C. Upper electrode (2) is formed to be hollow and at the same time to have a shower structure with many holes. Reaction gas will be blown into chamber (1) from upper nozzle (5). In addition, the inside of aforementioned chamber (1) is evacuated by a vacuum pump (not shown in the figure) to give a vacuum state of around 0.1-10 Torr. Note that symbol (6) represents a high-frequency power source connected to upper electrode (2).

[0012]

In a plasma CVD device such as this, to execute a requisite reaction process for workpiece (4)--to form, for example, a film of a certain type on the surface of said workpiece (4)--not only is workpiece (4) mounted on the aforementioned sample platform (3), but it is heated to a prescribed temperature, the inside of chamber (1) is brought to a vacuum state at a prescribed pressure by the vacuum evacuation system, and reaction gas is injected from upper nozzle (5), and, by impressing a prescribed high-frequency voltage between upper electrode (2) and sample platform (3), plasma is generated inside aforementioned chamber (1). Because of this, a film of a certain type is formed on the surface of aforementioned workpiece (4). In this case, a film is also formed and deposited on the inner wall surface of aforementioned chamber (1).

[0013]

During plasma treatment such as the aforementioned, the temperature of the inner wall surface of said chamber (1) rises due to generation of plasma inside chamber (1) and the temperature of the inner wall surface falls when plasma generation stops. So this cycle of temperature rise and fall is repeated each time multiple workpieces are sequentially processed. What regulates the temperature inside this chamber (1) is the temperature regulating mechanism of this invention.

[0014]

That is, the temperature regulating mechanism of this invention, as shown in Figure 1, has temperature sensor (10), heat exchanger (8), and cooling water jacket (7). Aforementioned temperature sensor (10) directly senses the temperature of the inner wall surface of said chamber (1), so it is provided near or touching the inner wall surface of said chamber (1) and is composed of, for example, a thermocouple, thermostat, or other temperature detecting element. Heat exchanger (8) produces cooling water at any temperature based on temperature signals sensed by aforementioned temperature sensor (8); so, for example, it will set an appropriate temperature for cooling chamber (1) according to temperature signals from aforementioned temperature sensor (10), and will heat or cool purified water that comes in from the outside to set the aforementioned temperature.

[0015]

Aforementioned heat exchanger (8) could have cold water (12) and hot water (13) prepared inside it beforehand, and could mix aforementioned cold water (12) and warm water (13) in any ratio by temperature signals sensed by the aforementioned temperature sensor (10) to

produce cooling water at any temperature. For example, a container in which cold water (12) is stored and a container in which warm water (13) is stored could be provided inside aforementioned heat exchanger (8); each could be kept at a prescribed temperature by heat-regulating system (14); temperature controller (11) could be operated based on temperature signals sensed by aforementioned temperature sensor (10); an appropriate temperature for cooling chamber (1) could be set by this temperature controller (11) to output control signal (S); opening of cold water system flow rate regulating valve (14a) and of warm water system flow rate regulating valve (14b) could be by this control signal (S); and aforementioned cold water (12) and warm water (13) could be mixed in any ratio. Note that symbols (15a) and (15b) represent check valves.

[0016]

In addition, cooling water jacket (7) circulates cooling water supplied from aforementioned heat exchanger (8) around aforementioned chamber (1), such that it is provided to surround said chamber (1), for example, inside the wall around chamber (1), and it is connected with heat exchanger (8) via cooling water supply line (9a) and return line (9b).

[0017]

Next, the operation of a temperature regulating mechanism constituted in this way will be explained. First, assume that workpiece (4) is mounted on sample platform (3) in aforementioned chamber (1), and that plasma treatment is performed to execute the requisite reaction process. In this case, the temperature of the inner wall surface of said chamber (1) rises due to generation of plasma and the temperature of the inner wall surface falls due to the generation ceasing; but the temperature of the inner wall surface of chamber (1) in this case is directly sensed by temperature sensor (10) that is installed on the inner wall surface. So the sensed temperature signals are sent to temperature controller (11), an appropriate temperature for cooling chamber (1) is set by operation of this temperature controller (11), and control signal (S) is output. That is, the temperature of the inner wall surface of aforementioned chamber (1) repeatedly rises and falls according to whether plasma is ON or OFF, as shown in dotted line curve (C1) in Figure 3; so in order to suppress this temperature change, the temperature of the cooling water is set to generate a temperature change with a curve that is in the exact opposite direction of the aforementioned dotted line curve (C1).

[0018]

Aforementioned control signal (S) is sent to two flow rate regulating valves (14a) and (14b). The opening of each valve (14a) and (14b) is controlled, cold water (12) and warm water

(13) inside heat exchanger (8) are mixed at any ratio, and cooling water at any temperature is produced. That is, when cooling water with a low temperature is to be produced, cold water system flow rate regulating valve (14a) could be opened more; and when cooling water with a high temperature is to be produced, warm water system flow rate regulating valve (14b) could be opened more. Cooling water produced in this way is supplied to cooling water jacket (7) that is provided around chamber (1) via supply line (9a); it is circulated around said chamber (1), cooling the inner wall surface thereof, and it is then returned to aforementioned heat exchanger (8) via return line (9b). The result is that, in contrast to the temperature change of the inner wall surface of chamber (1) shown by dotted line curve (C1) in Figure 3, by cooling with cooling water that has a temperature change with a curve the opposite direction from that, the temperature of the inner wall surface of aforementioned chamber (1) can be kept fixed, as indicated by solid line curve (C2) in Figure 3. Thus thermal stress caused by temperature change in the inner wall surface of aforementioned chamber (1) can be suppressed and separation of film adhered to the inner wall surface can be prevented.

[0019]

Note that, in Figure 1, an example where the requisite reaction process was executed for workpiece (4) with a plasma CVD device as the workpiece reaction device is shown, but this invention is not limited to this and it can be applied in the same way to a plasma etching device or sputtering device, etc.

[0020]

Effects of the invention

This invention is constituted as above, so the temperature of the inner wall surface of said chamber is directly sensed by a temperature sensor installed on the inner wall surface of the chamber, cooling water at any temperature is produced by a heat exchanger provided separately from the aforementioned chamber based on temperature signals sensed by the aforementioned temperature sensor, cooling water from the aforementioned heat exchanger is supplied to a cooling water jacket that is installed to surround the aforementioned chamber, and the temperature of the inner wall surface of the aforementioned chamber can be kept fixed by circulating cooling water around the chamber with the aforementioned cooling water jacket. Because of this, thermal stress caused by temperature change in the inner wall surface of the aforementioned chamber can be suppressed and separation of film adhered to that inner wall surface can be prevented. Thus, adhesion of foreign material to the workpiece can be prevented, and not only can the quality of the semiconductor products manufactured by improved, but yield can be improved.

Brief description of the figures

Figure 1 is a partial cross-section explanatory diagram showing an application example of a workpiece reaction device temperature regulating mechanism based on this invention.

Figure 2 is a partial cross-section explanatory diagram showing a conventional workpiece reaction device temperature regulating mechanism.

Figure 3 is a graph for explaining changes in the temperature of the inner wall surfaces of chambers in this invention and the conventional example.

Explanation of symbols

(1) ... chamber
(2) ... upper electrode
(3) ... sample platform
(4) ... workpiece
(6) ... high-frequency power source
(7) ... cooling water jacket
(8) ... heat exchanger
(9a) ... supply line
(9b) ... return line
(10) ... temperature sensor
(11) ... temperature controller
(14a), (14b) ... flow rate regulating valve

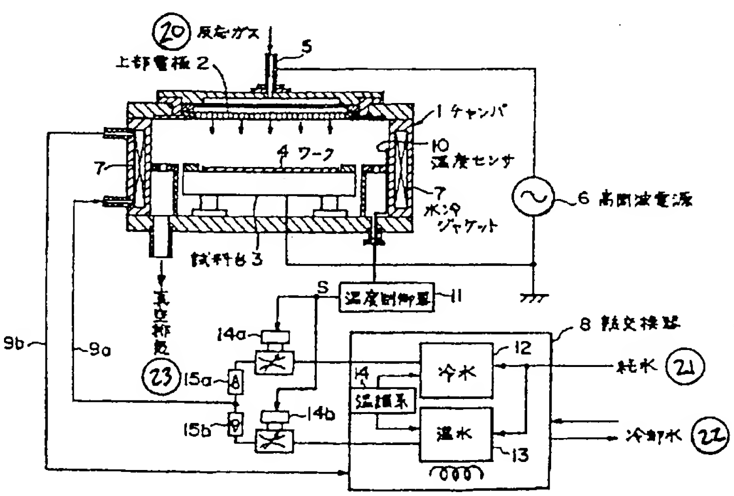

Figure 1

Key:
1 Chamber
2 Upper electrode
3 Sample platform
4 Workpiece
6 High-frequency power source
7 Cooling water jacket
8 Heat exchanger
10 Temperature sensor
11 Temperature controller
12 Cold water
13 Warm water
20 Reaction gas
21 Purified water
22 Cooling water
23 Vacuum evacuation

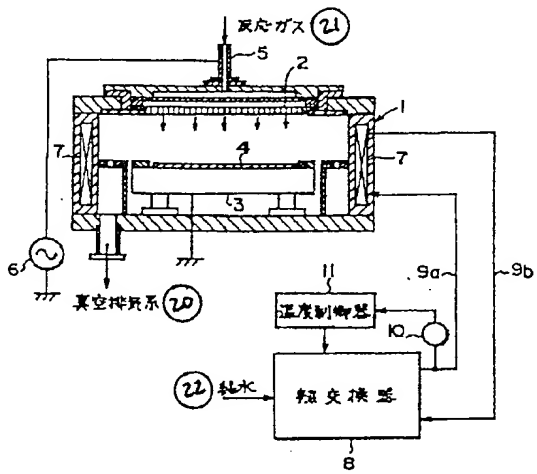

Figure 2

Key:
8 Heat exchanger
11 Temperature controller
20 Vacuum evacuation system
21 Reaction gas
22 Purified water